

1

# HIGHLY CONFIGURABLE MEDICAL ULTRASOUND MACHINE AND RELATED METHODS

## REFERENCE TO RELATED APPLICATION

This application claims the benefit under 35 U.S.C. §119 of U.S. patent application No. 61/091,285 filed 22 Aug. 2008 and entitled "HIGHLY CONFIGURABLE MEDICAL ULTRASOUND MACHINE AND RELATED METHODS", which is hereby incorporated by reference herein.

## TECHNICAL FIELD

This invention relates to medical ultrasound machines which can be configured to perform specific ultrasound data acquisition and/or measurement tasks. Embodiments of the invention provide ultrasound machines configured to acquire one or more ultrasound images and/or measurements according to a previously-defined ultrasound protocol.

## BACKGROUND

Modern ultrasound machines can operate in a range of imaging modes. In any imaging mode, the operation of an ultrasound machine can be adjusted by setting various parameters. The parameters can affect things such as the nature of acoustic signals emitted by the ultrasound machine, the way received echo signals are processed, and the way that ultrasound images are created and displayed. An ultrasound machine typically has a large number of controls that can be used to set the operating mode of the ultrasound machine and the parameters that will affect the operation of the ultrasound machine in that mode. This can be confusing, especially for inexperienced operators.

There is a need for ultrasound machines that are simple to operate. There is a particular need for ultrasound machines that are capable of sophisticated ultrasound imaging operations and are simple to operate.

## SUMMARY OF THE INVENTION

The invention has a variety of aspects. Aspects of the invention provide apparatus for operating ultrasound machines, apparatus for defining protocols for operating ultrasound machines and methods for operating ultrasound machines displays, controller for displays and methods for controlling displays.

In one method aspect, a method is provided for operating an ultrasound machine comprising the steps of: defining a protocol; making the protocol available to the ultrasound machine; invoking the protocol; and executing the protocol; wherein the protocol comprises a setup and the setup comprises a configuration of the ultrasound machine, a configuration of controls for operating the ultrasound machine, and a configuration of a display for the ultrasound machine.

In a related method aspect, the step of defining the protocol comprises the steps of performing an ultrasound exam using an ultrasound machine, the exam comprising one or more procedures; recording the controls used for operating the ultrasound machine during the one or more procedures; generating a draft protocol comprising one or more draft setups, each draft setup comprising a configuration of controls for operating the ultrasound machine that comprises the controls used during a corresponding procedure; and determining for

2

each draft setup whether each of the controls used during the corresponding procedure should be fixed or should be user-controllable.

In an apparatus aspect, apparatus is provided for operating an ultrasound machine comprising a protocol controller configured to execute a protocol to configure the ultrasound machine, configure controls for operating the ultrasound machine, and configure a display for the ultrasound machine.

In another apparatus aspect, apparatus is provided for defining protocols for operating an ultrasound machine comprising a display, wherein the display comprises graphical representations for a range of available controls for operating the ultrasound machine and an authoring area into which a user can introduce and arrange controls for operating the ultrasound machine.

Further aspects of the invention and feature of embodiments of the invention are described below and illustrated in the accompanying drawings.

## BRIEF DESCRIPTION OF DRAWINGS

Non-limiting example embodiments are illustrated in the appended drawings.

FIG. 1 is a block diagram illustrating a medical ultrasound machine according to an example embodiment of the invention.

FIG. 1A is a block diagram illustrating a medical ultrasound machine according to another example embodiment of the invention.

FIG. 2 is a flowchart illustrating a method for causing a medical ultrasound machine to perform a specific protocol.

FIG. 3 is a schematic view of a system for developing new imaging protocols for a configurable ultrasound machine.

FIG. 4 is a flowchart illustrating a method for operating an ultrasound machine to perform an ultrasound protocol.

FIG. 5A is an example of a possible touchscreen display for an image acquisition phase of a protocol.

FIG. 5B is an example context-sensitive help screen for the protocol step illustrated in FIG. 5A.

FIGS. 6A through 6D are example touchscreen displays for a number of successive stages in an example protocol for a focus assessment by sonography in trauma exam.

FIGS. 7A through 7C are example touchscreen displays for a number of successive stages in an example protocol for a freehand biopsy procedure.

## DETAILED DESCRIPTION

FIG. 1 is a block diagram of an ultrasound machine 10 according to an example embodiment. FIG. 1A is a more specific block diagram of an ultrasound machine 10A according to a specific example embodiment.

Referring to FIG. 1, machine 10 includes an ultrasound data acquisition stage 11 which acquires raw ultrasound data 13. Ultrasound data acquisition stage 11 may include, for example, a number of probes, each comprising an array of transducer elements. Raw ultrasound data 13 may comprise digitized ultrasound signals. Ultrasound data acquisition stage 11 provides raw ultrasound data 13 to an ultrasound processing stage 19. Ultrasound processing stage 19 processes raw ultrasound data 13 to produce ultrasound image data 17, which is provided to a display 20.

Ultrasound machine 10 includes a protocol controller 30. Protocol controller 30 can set the configurations of other parts of ultrasound machine 10. In the embodiment of FIG. 1, protocol controller 30 provides setup data 15 to ultrasound data acquisition stage 11 and ultrasound processing stage 19.